

6. On the Presence of two Ovaries in certain British Birds, more especially the Falconidæ. By T. E. GUNN, F.L.S.*

[Received October 23, 1911; Read November 7, 1911.]

(Plates II.—V.†)

In all vertebrated animals the reproductive organs or gonads are paired symmetrical glands lying to the inner side of the Wolffian body and in front of the kidney in the dorsal aspect of the body-cavity.

In the early stages of development these paired glands are found in every vertebrate from Fishes upwards. Morphologically indifferent at first, they become differentiated later on into the essential male (testis) or female (ovary) glands.

In exceptional cases a further change takes place leading to the suppression of one of the female gonads with its appendage, *e. g.*, certain Elasmobranch fishes, and—it is said—the whole class Aves. The suppression is supposed to be connected with the large size of the eggs developed by the individual, *e. g.*, *Scyllium* in fishes and *Uria* in birds.

In the embryo chick (of the fowl) the ridge of germinal epithelium is sufficiently differentiated by the fifth day to determine whether the primordial germ-cells of which it is largely composed are destined to furnish the individual with the permanent ova characteristic of the hen, or the spermatozoa of the cock bird: in other words, the ovaries are distinct from the testes at this date.

With regard to the male organs, their development pursues a normal course for the remainder of embryonic life, and the male chick steps out of the shell with two symmetrically placed and permanent functional testes.

With the female organs a further negative change takes place. The development of the ovary on the right side comes to a standstill and the organ atrophies, leaving little or no trace of its former presence. The oviduct dwindles with the ovary and is finally lost almost entirely; vestiges may be found more especially at the cloacal end of the tube, but it is never complete from end to end as a functional duct.

Exactly when this degeneration begins, and at what period of embryonic life the chick will be found with only the single left ovary, are apparently uncertain; but it is an accepted fact that the newly hatched female chick has but one ovary—that on the left side—and this one gland has to serve for the purposes of reproduction during the whole of her ovum-bearing existence.

Morphologists and ornithologists alike are agreed that adult female birds have but one functional ovary. Very few authors

* Communicated by F. MENTEITH OGILVIE, F.Z.S.

† For explanation of the Plates see p. 79.

make any reference even to remains of the right ovary being found on dissection, much less to a perfect functional organ, though they may allude to the persistence of portions of the Müllerian duct on that side.

Balfour* writes :—" In birds the left ovary alone is found in the adult, and is attached by the *mesovarium* to the dorsal wall of the abdominal cavity on the left side of the vertebral column."

Milnes Marshall† :—" In the embryo fowl there are two ovaries, but in the course of development the right ovary disappears and in the adult hen the left ovary is alone present. Of the two oviducts the right one is rudimentary ; the left one, which alone is functional, forms in the adult hen a wide convoluted tube."

And again ‡ :—" In the female, or hen bird (of the fowl) the Müllerian duct of the right side, like the ovary, disappears, though traces of it may persist in the adult—the left Müllerian duct becomes the oviduct."

Wiedersheim § :—" In *Sauropsida*, as in other vertebrates, the form of the gonads is influenced by that of the body ; thus in Chelonians they are broad, while in the snake and snake-like lizards they are more elongated and, as well as in other lizards, are asymmetrical, the organ of one side lying more or less in front of that of the other.

" More room is thus obtained for the development of the ovaries, and in cases where the eggs are very large the organs of one side tend to disappear as in certain elasmobranchs. In birds, for instance, the left ovary only is completely developed and functional. . . .

" In birds the right oviduct as well as the right ovary becomes more or less completely degenerated."

Lillie || :—" The organs of reproduction of the hen are the ovary and oviduct of the left side of the body. Although the right ovary and oviduct are formed in the embryo at the same time as those on the left side, they degenerate more or less completely in the course of development so that only functionless rudiments remain.

" This would appear to be correlated with the large size of egg and the delicate nature of the shell, as there is not room for the eggs side by side in the lower part of the body-cavity."

Alex. Macalister ¶ :—" There are two fasciculate ovaria, of which

* 'Elements of Embryology,' p. 11. Foster and Balfour, 1883.

† 'Vertebrate Embryology,' pp. 228-229. Milnes Marshall, 1893.

‡ *Ibid.* p. 320.

§ 'Comparative Anatomy of Vertebrates,' p. 474. Wiedersheim (adapted by Prof. W. N. Parker, 1907).

|| 'Development of the Chick,' p. 21. Lillie, 1908.

¶ 'An Introduction to the Systematic Zoology and Morphology of Vertebrate Animals,' (organs of reproduction in Birds) pp. 159-160. Alex. Macalister, 1878.

only one (the left) is developed and functional. The right oviduct remains a hydatic; sometimes is developed anomalously, while the left atrophies; rarely the two remain. (Pigeons and Parrots)."

Bowdler Sharpe* :—"The right ovary of birds is always atrophied, and it is only in rare cases that rudiments of it are found (namely in the diurnal *Raptores*). The right oviduct is not so completely atrophied as is the ovary of the same side."

In the recently published 'Grouse in Health and Disease' Dr. E. A. Wilson writes (of that bird) † :—"There is but one ovary, and it lies always on the left side of the backbone of the bird. This development of the ovary, only on one side, is the reason for advising the examination to be made, as detailed above, on the left side always."

This last quotation is interesting in connection with the subject of paired ovaries, since over 2000 grouse passed through the hands of the Grouse Disease Committee and were carefully examined; of these nearly a quarter (476) were females, and not a single example of a persistent right ovary or its remains was found ‡. It is to be noted, however, that if the sexing were carried out, as Dr. Wilson recommended, by examination of the left side, persistent right ovaries might have been overlooked.

Newton § :—"In the female a pair of ovaries are developed, but with rare exceptions only that on the left side becomes functional. In young birds both oviducts are almost equally developed, but the right one soon becomes reduced to an insignificant ligamentous strand along the ventral side or part of the kidney.

"This one-sided suppression of the organs may possibly be referable to the inconvenience that might be caused were each oviduct to contain an egg ready to be deposited."

From the above quotations it will be seen that the majority of the writers do not admit the presence of a right ovary at all in the adult female. Sharpe speaks of *rudiments* || of the right ovary being retained in the diurnal *Raptores*. Newton very guardedly refers to "rare exceptions" where both ovaries are present, but he does not mention in what species of bird these exceptions were found. It is indeed rather doubtful if these instances came under his personal observation; had they done so he would probably have published the names of the species and

* Cassell's Natural History, vol. iii, p. 251. R. Bowdler Sharpe, 1883.

† 'Grouse in Health and Disease,' vol. i. p. 60.

‡ Out of 17 female grouse that have passed through my hands in the last four years, three have shown well-marked paired ovaries.—T. E. G.

§ 'Dictionary of Birds,' ("reproductive organs") p. 782. Alfred Newton, 1894.

|| Italics are mine (T. E. G.).

details of the parts as he found them. Rev. F. C. R. Jourdain * suggests that Newton's exceptions might have been drawn from a German source †.

Professor Taschenberg, the writer of the article referred to by Jourdain, says:—

“It happens not very rarely that *remains* ‡ of the right ovary are retained, especially in the sparrow-hawk and buzzards, much more irregularly in other accipitres, and still more rarely in the owls.”

Ceteris paribus, a bird possessing two functional ovaries is clearly more fitted for the reproduction of its kind than the bird with only one. If disease or injury destroys the one ovary and spares the other, the bird can still fulfil the chief duty of its life, the bearing of ova. If the one ovary becomes exhausted (*e. g.* destruction of first nests) the other would act as a reserve to draw on in cases of necessity. If the fittest female is to survive in the long run, one would suppose that the bird that possessed the two complete genital tracts, the foundations of which were laid in the very early embryo, would surpass its fellow which had squandered fifty per cent. of its reproductive capital while still in the shell. That that is not the case we know.

Speaking in general terms, the rule holds good that adult females have but one ovary and one oviduct, those on the left side.

Why has the second ovary been abolished?

It has been suggested §, with some show of probability, that the suppression is in connection with the passage of the egg through the oviduct; that the danger involved by two eggs engaging simultaneously in the two oviducts would be very great, and would lead to fracture of the delicate shell, or rupture of the walls of the containing duct; to peritonitis, intestinal obstruction or some such calamity, and in any event death.

If such an accident—a fully-developed egg in the lower part of either oviduct at the same time—were to happen, no doubt the results would be untoward. A Guillemot with two full-sized eggs in its abdomen would presumably burst.

But is it necessary to suppose that such a sequence would follow the presence of two separate genital tracts?

I think not. The number of cases collected in this paper goes far to prove that death and disaster are neither the necessary nor even the common result of paired ovaries. It is contradicted by the frequency with which the Falconidæ are found with paired ovaries which are obviously functional. That a single ovary permits the bird to perpetuate its kind is true enough. The

* ‘British Birds,’ Dec. 1910, p. 218.

† ‘Naturgeschichte der Vögel Mitteleuropas,’ vol. i. p. 60, 1905. [Dr. Gadow, in Bronn’s ‘Thier-Reich, Vögel,’ p. 842, quotes from Stannius, and adds instances from his own observation of the persistence of the right ovary, particularly in diurnal birds of prey.—EDITOR P. Z. S.]

‡ Italics are mine (T. E. G.).

§ Newton, ‘Dictionary of Birds,’ p. 783.

excretion of urea can be carried on by one kidney if the other be destroyed by disease, or removed in its entirety by the surgeon; but the animal with one kidney only is admittedly less well off than the animal with the normal pair. The life would be called a bad one at any vertebrate life insurance office, and the premium charged would be correspondingly high. Two ovaries may not be a necessity, but they must be better than one. The suppression of the second ovary appears to be a retrograde step for which it is hard to find any adequate reason, and is almost without a parallel in vertebrate embryology.

In dissecting an immature female Sparrow-hawk (*Accipiter nisus*) (plumage of the first year) shot on the 9th of January, 1892, I found both ovaries equally developed, containing small eggs of uniform size.

In the following April a second example came under the notice of Mr. F. Menteith Ogilvie, who had happened to be with me when I skinned and examined the former specimen. He made the following note:—"April 11th, 1892. I dissected *A. nisus* ♀. Both ovaries well developed, eggs numerous and of various sizes—I think the forward condition of the ova shows the bird would have bred this season, though it was certainly only a last year's bird."

From 1892 up to the present date I have paid special attention to the sexual organs of all birds passing through my hands, in order to investigate the condition of the female generative system, the frequency with which the right ovary was found to persist, and the species in which such persistence occurred. In every case where paired ovaries were found I took notes and made as accurate sketches as I could with the specimen on the table before me. In 1895 and again in 1903 I recorded a number of these instances in two papers read at meetings of the Norwich Science Gossip Club*. Since then further examples have been added, bringing the total number of specimens with paired ovaries in my series to 45. These are grouped in bulk in Table I. (see p. 72), and are separately treated in detail in the Appendix.

Neither Table I. nor the Appendix includes several instances in which I have found the two ovaries in certain nestlings.

On July 7th, 1909, six nestling Sparrow-hawks with their parents (second year's plumage) were sent me from Suffolk (see Appendix 10^a). In sexing the nestlings I found that five were females and the sixth, a much smaller bird, a male. All the five female nestlings had paired ovaries, the glands averaging half an inch in length. They were equally developed and easy to recognise. The excessive proportion of females over males in the Sparrow-hawk in this instance is noteworthy—I have observed the same fact on a former occasion †, in which, out of six nestlings, four were females and two were males.

* Report of Proceedings, May 1895; May 1903.

† 'Zoologist,' 1885, p. 51.

Exceptions to the rule that breeding females possess but a single left ovary must be very considerable. Since especially looking for paired ovaries I have found them comparatively common—the natural inference is that for many years I had overlooked them.

The number of examples of paired ovaries, apparently functional and ready for ovulation in this series, negatives the idea of the danger to life necessarily involved by the possession of a paired generative system. If death were the common result of a right and left ovary (with the corresponding ducts) it would seem likely that specimens would have come to hand before now demonstrating the pathology of the fatality and its mode of occurrence. I have never handled such a bird in the flesh, nor seen any reference in print to dissections illustrating death from this cause.

Is it not a reasonable conception that the nervous system would govern the activity of the ovaries—and of course the oviducts—during the period of turgescence associated with the breeding season, utilizing the left ovary only, or the right ovary only for the egg-supply and the other for a reserve—or in cases of necessity utilizing both ovaries?

(a) In most of the later examples of paired ovaries in a state of activity in my series—birds that were obtained in June and early July and had then laid their full complement of eggs for the season—all the evidence goes to show that though two ovaries were present only one has been utilized for the production of eggs (*cf.* 1^c; 8^a); the other ovary developing eggs up to a point—the eggs then ceasing to grow in size and finally shrinking with those in the working ovary to the small undeveloped ova common to birds in the non-breeding season.

In some of the earlier examples—birds obtained between March and early May (*cf.* 5^c; 1^d; 2^a; 2^b)—both ovaries are well and equally developed with eggs of approximately equal size in either ovary—so that at this time it is impossible to guess which ovary is to furnish the season's eggs, or whether the supply is to be drawn from both.

This seems to point to the nervous system determining which ovary shall be finally selected for the year's output.

Both ovaries are developed up to a certain point; and then one comes to a standstill, while the requisite number of eggs in the other continue to increase in size until they are ripe for the oviduct. After they are shed both ovaries rapidly undergo the normal process of involution and become comparatively insignificant.

According to this theory the regulating nervous stimulus could be switched off one ovary and on to the other as best suited the requirements of the organism.

(b) If both ovaries are to share in the production of one clutch of eggs, then one can imagine each oviduct in turn being inhibited, while an egg is engaged in the duct of the opposite side, much as

a signalman refuses to accept a new train until his section is cleared of the old one.

(c) Finally there remains the question whether *one* oviduct can serve *two* ovaries. There is not much evidence for or against this supposition.

In some cases the appearance of the paired ovaries rather suggests that *both* had taken part in discharging ripe ova, while only *one* oviduct shows much development.

On the other hand, the normal involution of the oviduct is so extraordinarily rapid, that in some specimens with well-developed ovaries, which are known to have passed the last eggs of their clutch quite recently (3^c), the oviducts on both sides are merely represented by ill-defined strands quite difficult to differentiate macroscopically from the surrounding tissues, and but little more marked than the oviduct (or ducts) would be in the autumn and winter months.

The upper portion of the oviduct is provided with a mesentery which is sufficiently long to allow a very considerable amount of free play. There seems no physical objection to the open end of the tube (*ostium abdominale*) swinging across the mid-line of the spine *, and grasping the ripe ovum of the opposite ovary with nearly the same facility as the ovum of its own side.

Extra-tubal gestation, by which I mean the shedding of a ripe ovum into the peritoneal cavity, is, so far as we know, an exceedingly rare accident among birds. Dr. Wilson † mentions such a case.

Two functional ovaries and one duct collecting eggs from both sides would be exactly the conditions which would predispose to such an occurrence.

Returning to the paired ovaries, it is manifest that these cases are not exceedingly rare among many quite widely separated groups of British birds. In one family, the Falconidæ, such instances may be termed positively common. One cannot help realising that if 45 examples come under the notice of one man in the course of nineteen years, double ovaries must be something more than of occasional occurrence.

The obvious conclusion seems to be that they are not found because they are not looked for.

In the writings of English ornithologists I can find but one specific record (and that a very recent one) of paired ovaries.

Dr. C. B. Ticehurst ‡ describes three cases in which he found the right ovary persisting—all three examples were Sparrow-hawks.

* Except in the Falconidæ the examples of paired ovaries generally show an asymmetrical state of affairs, with the right ovary below the left, and at the same time carried over somewhat laterally from right to left. In such cases as these the left oviduct would have no further to go for the eggs from the right ovary than for those from the left.

† 'Grouse in Health and Disease,' p. 183.

‡ 'British Birds,' November 1910, p. 188.

Some very excellent notes on the subject by Signora C. Picchi appear in the July (1911) number of 'British Birds,' pp. 45-49.

This lady gives 27 examples of a persistent right ovary, the large majority of them (25 out of 27) are found among the Falconidae, especially the genera *Falco* and *Circus*.

For the purposes of this paper I have reduced Signora C. Picchi's notes to a tabulated form (Table II., p. 73) in order to render it readily comparable with the table (Table I.) constructed from my own series.

Ornithologists expect to find either two testes or one ovary. The intestines and peritoneal folds are raised and gently turned over from the (bird's) left to right, which of course exposes the left half of the dorsal wall of the body-cavity. In the case of the female the left ovary is satisfactorily identified, and there the dissection usually stops.

The conditions obtaining on the right side of the body-cavity are not investigated at all,—a second ovary may or may not be present, but by this method of examination it is effectually hidden by the pile of intestines pushed over from the left side.

The percentage of double ovaries found in this paper in certain genera in the family (*Circus* 9 out of 12, *Accipiter* 14 out of 20) is so large that one is forced to the conclusion that individuals of the same genera dying in captivity would also furnish a considerable percentage of paired ovaries.

In the 45 instances of double ovaries referred to (Table I., group 1) nearly three quarters (33 out of 45) are of one family, the Falconidae.

In Signora C. Picchi's notes (Table II., group 1) 27 examples are given, and of these 25 are drawn from the same source.

The remaining twelve examples in my series (Table I., group 2) represent seven species that, with the exception of the two Grouse, are widely separated. The seven species in fact belong to six different orders.

The remaining two in Signora C. Picchi's notes (Table I., group 2) also occur in two very diverse species, one of them being an Owl (*Striges*) and the other a Rook (*Corvus*).

Oddly enough, I have no note of paired ovaries among the Strigidae; but that may be due to so few of these birds passing through my hands in recent years, owing to the wise protection which is now almost universally afforded owls in this country.

Table I. (T. E. G.) and Table II. (C. Picchi) show clearly enough that the right ovary *does* persist in not a few cases; that it is sometimes developed equally with the left and sometimes very considerably exceeds that gland.

1^e (*Circus cineraceus*), in which the right ovary has several large ripe ova whereas those of the left are small.

8^a (*Accipiter nisus*). The right ovary is but fragmentary, and shows only three ova: one as large as an ordinary sized marble, another about one third that size, and the third about as large as a hempseed. Those of the left were quite small. The right ovary had evidently been the source from which the season's eggs

had been derived, and had become nearly exhausted: the left ovary, on the other hand, showed little more activity than the quiescent gland of the autumn months.

7^b (*Falco tinnunculus*). The left ovary contained a cluster of eggs of even size with one slightly larger—the left oviduct well developed. The right ovary contained but six very small eggs, and the oviduct was represented by only a narrow ligamentous strand.

14^a (*Accipiter nisus*). Both ovaries were present, the right half the size of the left, and contained small eggs only.

Of the *oviducts* the right was double the width of the left and had the appearance of having recently passed eggs.

12^a (*Accipiter nisus*). Both ovaries and their corresponding ducts present, the left oviduct being the wider.

This female had probably quite recently passed her full clutch of six eggs, which were taken from the nest by the keeper at the same time that he killed the parent bird. The remaining eggs in both ovaries were all small. The left oviduct had quickly become reduced in width after passing the last of the six eggs, which event must have taken place not more than two days before.

From the greater width of the left oviduct in 7^b, of the right in 14^a, of the left in 12^a, we may reasonably infer that they had severally been the latest oviducts in active service.

This indicates that either the right or the left oviduct may be the functional one—and that one or other may work as the maturity of the ova in each respective ovary requires their service.

In conclusion I would again draw attention to Tables I. and II.

In Table I., to take two extreme instances, out of *six* female Hen Harriers (*Circus cyaneus*) examined *five* had a persistent right ovary: out of *fifty* female Woodcock (*Scolopax rusticula*) examined only *one* retained the gland on the right side.

If the figures in the two tables are combined we get the following results:—

Grand total, 72 examples of paired ovaries out of 212 females examined, made up of two sub-divisions A and B.

A. Falconide	56 out of 98.
B. Species from any family other than the Falconide	14 out of 112.

This shows in rather a startling manner the frequency with which paired ovaries are found in the Falconide (or rather in the genera which have come under examination) as compared with any other family of British birds.

There is a second point of some interest in regard to the anatomical position of the ovaries. In the Falconide these are symmetrically placed and are arranged, almost without exception, parallel to each other, and on about the same level, lying on the kidney of the same side and separated from each other by the vertebral column.

TABLE I.

Compiled from T. E. Gunn's notes: enumerating the species examined and the proportion the double ovaries occurred. Specimens obtained in Great Britain.

	Sparrow-Hawk	<i>(Accipiter nisus)</i>	14	out of 20 ♀	examined.		
A. Falconidæ (7 species) 33 out of 50 ♀ examined =66%.	Falcon 10 18 =66%.	Kestrel	8	"	12 "		
		Hobby	1	"	2 "		
		Peregrine	1	"	4 "		
	Circus 9 12 =75%.	Hen Harrier	5	"	6 "		
		Montagu's Harrier .	3	"	4 "		
		Marsh Harrier	1	"	2 "		
	B. Families other than Falconidæ (7 species) 12 out of 101 ♀ examined =11.88%.	Great Crested Grebe..... Red Grouse .. Black Grouse .. Bewick's Swan .. Water Rail .. Woodcock .. Little Gull.....	<i>(Podiceps cristatus)</i>	2	"	4 "	
			<i>(Lagopus scoticus)</i>	3	"	17 "	
			<i>(Tetrao tetrix)</i>	1	"	5 "	
			<i>(Cygnus bewicki)</i>	1	"	4 "	
<i>(Rallus aquaticus)</i>			2	"	7 "		
<i>(Scolopax rusticula)</i>			1	"	50 "		
<i>(Larus minutus)</i>			2	"	14 "		

In examples of paired ovaries found in birds other than the Falconidæ, the arrangement of the ovaries is more irregular and uncertain. They are seldom symmetrically placed, the general tendency being for the right ovary to move downwards and to the left, so that the whole of the left ovary and the greater part of the right are contained in the left half of the body-cavity, one ovary more or less overlapping the other.

It would appear possible that the partial migration of the right ovary to the left side and below the left ovary may be of importance as furnishing more space for the development of the ovaries. It probably does mark a milestone on the road leading to its final disappearance.

TABLE II.

Compiled from Signora Cecilia Picchi's notes published in 'British Birds,' July 1911, Vol. V. No. 2, pp. 45-59. Specimens obtained in Italy with the exception of two from Sardinia.

	Sparrow-Hawk	(<i>Accipiter nisus</i>)	3 out of 7 ♀ examined.			
A.	Falconidae (11 species) 23 out of 48 ♀ examined =48% (47-91).	Falcon 9 18 =50%	{ Kestrel	(<i>Falco tinnunculus</i>)	2 " " 6 " "	
			{ Lesser Kestrel*	(<i>F. cenchris</i>)	1 " " 2 " "	
			{ Merlin	(<i>F. aesalon</i>)	2 " " 4 " "	
			{ Red-footed Falcon ..	(<i>F. vespertinus</i>)	5 " " 8 " "	
			{ Hobby*	(<i>F. sublaetco</i>)	1 " " ? " "	
			Circus 7 11 =50%	{ Hen Harrier	(<i>Circus cyaneus</i>)	1 " " 4 " "
				{ Marsh Harrier	(<i>C. aeruginosus</i>)	4 " " 6 " "
				{ Pallid Harrier	(<i>C. macrurus</i>)	2 " " 4 " "
				{ Common Buzzard	(<i>Buteo vulgaris</i>)	3 " " 6 " "
				Serpent Eagle	(<i>Circus gallicus</i>)	1 " " 3 " "
B.	Families other than Falconidae (2 species) 2 out of 11 =18%.	{ Short-eared Owl	(<i>Asio accipitrinus</i>)	1 " " 5 " "		
		{ Rook	(<i>Corvus frugilegus</i>)	1 " " 6 " "		

* Not included in the figures, as the number of females examined is not known.

I have to express my thanks to Mr. F. Monteith Ogilvie, who has taken a great interest in the subject from the first, and has given me much advice and assistance in the construction of the paper. I am further indebted to him for obtaining the stereoscopic photographs * of some of the later specimens, microscopical sections of the paired ovaries 5^e and 2^e, and photographs of these same sections under low and medium magnifications.

* The stereoscopic photographs were taken by Mr. W. Chesterman, of the Department of Human Anatomy; Plates II. and UI. were executed from Mr. Gunn's original drawings by Mr. C. J. Bayzand, of the Department of Geology, University of Oxford. —(F. M. O.)

APPENDIX.

SPARROW-HAWK (*Accipiter nisus*). $\frac{14}{20}$ †(Pl. II, figs. 2^a-14^a; Pl. IV, fig. 1.)

1^a. Date, January 9th, 1892. Locality, Suffolk. Age 8 to 9 months. Both ovaries present, each containing small eggs.

2^a. May 21st, 1894. Suffolk. In second year's plumage. Paired ovaries of equal size, being filled with uniform eggs.

3^a. November 8th, 1900. Norfolk. In second year's plumage, showing both ovaries: eggs small, and uniform in size.

4^a. December 20th, 1906. Derbyshire. Two years of age. Right and left ovaries nearly equal in size. Right a trifle the larger, both filled with cream-coloured eggs.

5^a. February 1st, 1907. Suffolk. Entering its second year. Both ovaries present, the right being larger, and the ova uniform in size.

6^a. October 3rd, 1908. Suffolk. In its first year's plumage. Two small thin ovaries present. Right larger than left. Eggs very small.

7^a. October 7th, 1908. Norfolk. First year's plumage. Two ovaries present, right trifle the larger. Eggs small.

8^a. May 7th, 1909. Suffolk. In its second year's plumage. Two ovaries with eggs, the right having three eggs, one as large as an ordinary marble, the second about one third its size, and the third about the size of a hempseed. The left ovary contained two as large as hempseed, the remainder very small.

9^a. * June 9th, 1909. Suffolk. Two years old. Two ovaries present, the right being larger and containing one large egg, the remainder very small and presenting three different colours, pale yellow, cream, and black.

10^a. July 7th, 1909. Suffolk. In second year's plumage. Two ovaries present, the right as large again as the left, both containing small cream-coloured eggs. The full clutch of six nestlings was sent with the parent birds. Of these five were females and one a male; all five females had well-defined paired ovaries.

11^a. May 26th, 1911. Suffolk. Two ovaries, apparently exhausted, and too decomposed to preserve.

12^a. * May 26th, 1911. Norfolk. Not less than three years old. Both ovaries nearly equally developed. The left oviduct much wider than the right. This bird had laid its full complement of six eggs; quite fresh when taken by the keeper.

* Preserved as a museum specimen.

† In the fractions at the head of each species the numerator indicates the number of examples of paired ovaries found, and the denominator the total number examined,

$\frac{14}{20}$ is interpreted 20 females of *A. nisus* examined and 14 found with paired ovaries.

13a. † May 27th, 1911. Norfolk. Age two years. Two ovaries present and equally developed. I examined this bird the day after death; it had been exposed to the sun, so was somewhat decomposed, but I was able to preserve the ovaries. Its six fresh eggs were also taken by the keeper.

14a. ‡ June 8th, 1911. Suffolk. Second year. Both ovaries present. The left containing small and larger eggs. The right with small eggs only. The two oviducts well developed, that of the right being twice the width of the left. The ostium abdominale of the left duct is well shown in this specimen.

KESTREL (*Falco tinnunculus*). $\frac{8}{12}$.

(Pl. II. figs. 1^b-8^b.)

1^b. January 15th, 1901. Norfolk. Adult. Two ovaries present, but not equal in size, the right ovary being about half as large as the left, but the oviduct was more prominent in the right.

2^b. * June 7th, 1909. Suffolk. Adult plumage. Two ovaries present, the right small, the left quite four times as large as the right. Eggs of two sizes, the larger of a pale cream, a few of the smaller that were scattered were of a rich yellow colour.

3^b. * June 7th, 1909. Suffolk. Adult. Two ovaries, the right a small dark gelatinous mass with small eggs; the left about six times as large and contained eggs of various sizes of a yellow colour, a dark gelatinous mass being in the centre.

4^b. May 24th, 1910. Norfolk. Adult plumage. Two ovaries about equal in size, the eggs in the right ovary somewhat the larger.

5^b. May 25th, 1910. Suffolk. Second year's plumage. Two ovaries present. The right in a fragmentary state but containing a few eggs of two sizes. The left ovary was about six times larger, with eggs of various sizes, none large.

6^b. § January 6th, 1911. Norfolk. Second year. Both ovaries present. The left as large again as the right. Eggs small and of uniform size. Both oviducts thin; the left very attenuated.

7^b. * May 10th, 1911. Suffolk. Two years old. Left ovary full of eggs of uniform size, with the exception of a single larger one. Left oviduct exceedingly well developed, right ovary small and fragmentary; six small eggs only; right oviduct a fine ligamentous strand.

8^b. * May 26th, 1911. Suffolk. Age two years. Both ovaries present. The left larger and full of eggs, the right ovary smaller with fewer eggs, two of which were, however, larger than those in

* Preserved as a museum specimen.

† Stereoscopic photograph of the ovaries *in situ*.

‡ Sections of the right and left ovaries; photographs of the same.

§ Stereoscopic photograph of the ovaries *in situ*.

the left. Both oviducts represented by thin strands only, the left being more evident.

HEN HARRIER (*Circus cyaneus*). $\frac{5}{6}$.

(Pl. III. figs. 1^c-5^c; Pl. IV. fig. 2; Pl. V. figs. 1-4.)

1^c. November 4th, 1893. Norfolk. Second year. Both ovaries present; eggs of a rich cream colour, small and of uniform size.

2^c. April 9th, 1900. Suffolk. Probably three years old. This bird possessed two ovaries which contained eggs of two sizes.

3^c. January 10th, 1908. Norfolk. In second year's plumage. Both ovaries present, the left one as large again as the right. Both filled with small eggs of uniform size.

4^c. January 7th, 1907. Suffolk. In its second year. Two ovaries present; the left slightly the larger. Full of small eggs.

5^c. * † March 30th, 1911. Norfolk. Age two years. Both ovaries equal, containing cream-coloured eggs of two sizes; the majority small, the right ovary having more larger-sized eggs than the left. The two ovaries were packed closer together than any I had hitherto seen.

MARSH HARRIER (*Circus aeruginosus*). $\frac{1}{2}$.

(Pl. III. fig. 1^d.)

1^d. April 17th, 1907. Derbyshire. Two years old. Both ovaries present, the left a trifle the larger; both full of small eggs of uniform size.

MONTAGU'S HARRIER (*Circus cineraceus*). $\frac{3}{4}$.

(Pl. III. figs. 1^e-3^e.)

1^e. May 15th, 1903. Suffolk. Adult, three to four years old. Both ovaries present, the right containing much larger eggs of varying sizes, the largest just half an inch in diameter, and most of them of a bright orange colour. The left ovary contained small eggs of a yellowish cream colour.

2^e. July 3rd, 1909. Suffolk. Two years old. The two ovaries present. Eggs very small, uniform in size, and of two shades of colour—pale and deep yellow.

3^e. ‡ June 17th, 1911. Suffolk. Adult, probably three years. Two ovaries equal; containing a mass of eggs of various sizes and

* Sections of the right and left ovaries; photographs of the same.

† Stereoscopic photograph of the ovaries *in situ*.

‡ Sections of the right and left ovaries; photographs of the same.

of pale yellow and flesh colour; the left oviduct a fine strand only, that of the right very fine and thin.

HOBBY (*Falco subbuteo*). $\frac{1}{2}$.

(Pl. III. fig. 1^f.)

1^f. June 6th, 1907. Suffolk. Two years old. Two ovaries present; the left contained five large eggs, and the right some very small ones.

PEREGRINE FALCON (*Falco peregrinus*). $\frac{1}{4}$.

(Pl. III. fig. 1^g.)

1^g. November 22nd, 1907. Suffolk. Three years old. Two ovaries present, the right small and thin, with small eggs; the left was quite four times larger and had some eggs of two sizes.

GREAT CRESTED GREBE (*Podiceps cristatus*). $\frac{2}{4}$.

(Pl. III. figs. 1^h, 2^h; Pl. IV. fig. 3.)

1^h. * November 26th, 1910. Suffolk. Two ovaries, the right below the left and overlapped by it; both filled with small eggs. The upper (left) ovary the larger.

2^h. † February 28th, 1911. Norfolk. Probably three years old. Two ovaries present, the left slightly larger than the right; eggs of various sizes and of a yellow colour. The right ovary below the left and slightly overlapped by it.

RED GROUSE (*Lagopus scoticus*). $\frac{3}{17}$.

(Pl. III. figs. 1j-3j.)

1j. October 26th, 1907. Argyllshire. Two ovaries, situated side by side, the right double the length of the left. Both filled with small eggs of uniform size.

2j. October 26th, 1907. Argyllshire. Two ovaries; same remarks as above.

3j. November 29th, 1910. Argyllshire. Two ovaries of equal size and rounded form. The left ovary is superior and is overlapped by the right ovary, which lies nearly directly below it.

BLACK GROUSE (*Tetrao tetrix*). $\frac{1}{2}$.

(Pl. III. fig. 1^k.)

1^k. August 30th, 1907. Staffordshire. Probably three years old.

* Stereoscopic photograph of the ovaries *in situ*.

† Preserved as a museum specimen.

This bird had partly assumed the plumage of the male with its black breast and forked tail, the rest of the plumage being a mixture of black cock and grey hen.

Two ovaries present and equally developed, the left slightly overlapping the upper part of the right ovary; both contained eggs of uniform size.

BEWICK'S SWAN (*Cygnus bewicki*). $\frac{1}{4}$.

(Pl. III. fig. 1¹.)

1¹. January 5th, 1900. Scotland. Adult. It possessed two ovaries; one placed in front and nearly covering the other. The front and larger one was undoubtedly the right ovary and contained eggs of various sizes; the left was smaller, containing eggs of uniform size.

WATER RAIL (*Rallus aquaticus*). $\frac{2}{7}$.

(Pl. III. figs. 1^m, 2^m.)

1^m. *† December 27th, 1907. Suffolk. Both ovaries present, the left slightly the larger, and above the right, which it overlaps at the upper part. Each ovary is filled with small eggs of uniform size.

2^m. December 26th, 1910. Norfolk. Two ovaries equally developed, and as in previous instance, one is situated immediately above the other, eggs being uniform in both.

WOODCOCK (*Scolopax rusticula*). $\frac{1}{50}$.

(Pl. III. fig. 1ⁿ.)

1ⁿ. December 9th, 1909. Argyllshire. Two ovaries present, and situated one above the other, the left overlapping the upper part of the right. This latter ovary is slightly the larger and seemed partially twisted at its extremity; both full of small uniform eggs.

LITTLE GULL (*Larus minutus*). $\frac{2}{14}$.

(Pl. III. figs. 1^o, 2^o.)

1^o. February 5th, 1902. Suffolk. Bird in immature plumage, *i. e.* first year. The right and left ovaries are present, and meet in an apex above with a small blood-vessel overlying the junction. Both ovaries filled with small eggs.

2^o. January 6th, 1906. Suffolk. Adult. Both ovaries present, and arranged side by side; the right is twice the length and size of the left, and both are full of small cream-coloured eggs of uniform size.

* Stereoscopic photograph of the ovaries *in situ*.

† Preserved as a museum specimen.

EXPLANATION OF THE PLATES.

For further details see Appendix (p. 74).

PLATE II.

Paired Ovaries.

- Figs. 2^a-14^a. Sparrow-Hawk (*Accipiter nisus*).
 1^b-8^b. Kestrel (*Falco tinnunculus*).
 (r., right ovary. l., left ovary.)

PLATE III.

Paired Ovaries.

- Figs. 1^c-5^c. Hen Harrier (*Circus cyaneus*).
 1^c. Marsh Harrier (*C. aeruginosus*).
 1^c-3^c. Montagu's Harrier (*C. cineraceus*).
 1^c. Hobby (*Falco subbuteo*).
 1^c. Peregrine Falcon (*Falco peregrinus*).
 1^b, 2^b. Great Crested Grebe (*Podiceps cristatus*).
 1^b-3^b. Red Grouse (*Lagopus scoticus*).
 1^k. Black Grouse (*Tetrao tetrix*).
 1^c. Bewick's Swan (*Cygnus bewicki*).
 1^m, 2^m. Water Rail (*Rallus aquaticus*).
 1ⁿ. Woodcock (*Scolopax rusticula*).
 1ⁿ, 2ⁿ. Little Gull (*Larus minutus*).
 (r., right ovary. l., left ovary.)

PLATE IV.

Paired Ovaries.

- Fig. 1. Sparrow-Hawk (*Accipiter nisus*) $\times 1\frac{1}{2}$. Both ovaries present, the right nearly exhausted and containing small eggs only. Both oviducts well developed; the right three or four times the size of the left and apparently the last in use; the left oviduct is well defined, the ovarian end of the duct is turned directly downwards and to the left, and the *Ostium abdominale* is clearly seen. (Appendix 14^a.)
 2. Hen Harrier (*Circus cyaneus*) $\times 1\frac{3}{4}$. Symmetrical paired ovaries equally developed and containing eggs of approximately the same size. (Appendix 5^c.)
 3. Great Crested Grebe (*Podiceps cristatus*) $\times 1\frac{1}{2}$. Asymmetrical paired ovaries. The right ovary lies below the left, and is mostly in the left half of the body-cavity. (Appendix 2^b.)

PLATE V.

Microscopic sections of the ovaries of the Hen Harrier (*Circus cyaneus*).
 (Appendix 5^c).

- Fig. 1. Left ovary $\times 4\frac{1}{2}$ showing general ovarian structure.
 2. A selected ovum from fig. 1 showing germinal spot, protoplasm, germinal epithelium, and vascular connective tissue capsule ($\times 60$).
 3. Right ovary $\times 5$.
 4. A selected ovum from fig. 3 $\times 50$.